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Borås, a Zero Waste City in Sweden

Karthik Rajendran, Hans Björk and Mohammad J. Taherzadeh

Abstract

Waste is a wealthy resource in the city of Borås in Sweden. The city has developed a sustainable waste management mechanism by reducing landfill, recovering fuel from the waste and recycling in collaboration with University of Borås, local municipality and other private partners. The system was designed back in 1986 to convert waste into value-added products such as biogas, electricity and heat. Hardly less than 1% of waste ends in landfills, thus Borås has given a new model of utilizing waste in a useful and economical way for a better environment. In most of the countries the waste is thrown away in the landfills which leads to health hazards, safety issues and loss of valuable resources. The Borås model emphasizes on "reduce, recycle and recover energy" before dumping. Before 1996 more than 40% of waste was landfilled in Sweden and today it has approached to zero landfill. The household waste is sorted in 30 fractions and then used. In a city of 100,000 population through using waste more than 3 million m³ biogas is produced every year which runs the buses, garbage trucks and around 300 CNG vehicles in the city. 960 MWh heat and electricity is also generated everyday. More than 90% recycling of PET and aluminum bottles is done in Sweden. The University of Borås actively conducts research and workshops in the sector. This public, private partnership model has made Borås a zero waste city.

Acronym/Abbreviations

MSW: Municipal solid waste, WR: Waste Recovery

Introduction

Sweden is one of the pioneers in resource recovery and waste management sector for more than 30 years. City of Borås has a great impact on Sweden in sustainable waste management by reducing landfill, recovering fuel from the waste and recycling. From 2006, collaboration called "Waste Recovery - International Partnership" between University of Borås, Borås Energy and Environment (local municipality), SP technical research institute of Sweden, and about 20 other private companies and organizations was started, in order to share Swedish knowledge and technology on sustainable waste management with other countries. The first project of this organization was carried out in collaboration with Indonesia and expanded since 2008 to Southeast Asia (Thailand, Vietnam, Cambodia, and Laos and recently India), Latin America with Brazil in focus, West Africa (Nigeria, Ghana), the USA, etc.

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Dimension of waste in different countries

Waste is a waste elsewhere, but for Borås it is a wealthy resource. Having a population of more than 100,000, a positive economic system was designed back in 1986 to convert wastes into value-added products such as biogas, electricity and heat. The waste management system in Borås was started with 3,000 households as a pilot project. Then, the complete city was adopted to the waste management system. Nowadays, some countries in Europe have proper waste management, including Sweden, Germany, Austria, Switzerland and Netherlands, in which less than 1% of waste is ended in landfill. However, Eastern European countries such as Romania and Bulgaria end up with more than 99% of waste in landfills. The situation is worse in many developing countries. Ending up the waste in landfills leads to loss of land, loss of useful materials, generation of poisonous gases and leachate, climate change etc. Utilizing the waste in a useful and economical way can protect the environment for a better future.

Globally, more than 2,000,000,000 tons per year municipal solid wastes (MSW) is generated, in addition to agricultural, forestry and industrial wastes. Most of these wastes end up in landfills, as the most common way to get rid of the waste problem is the 'throw-away' strategy. However, throwing away leads to health hazards, safety issues and loss of the valuable resources. The local government has a major responsibility in collection, transportation and processing of waste. Many governmental companies dump the waste, as they cannot generate value and positive economy from the wastes. However, back in 1960s and 1970s, the waste was increasing beyond the acceptable levels, and led to the change in the framework directives and policies which formulated waste management hierarchy. According to the waste management hierarchy, the wastes should follow "reduce, reuse, recycle and recover energy" before it is dumped into the landfills.

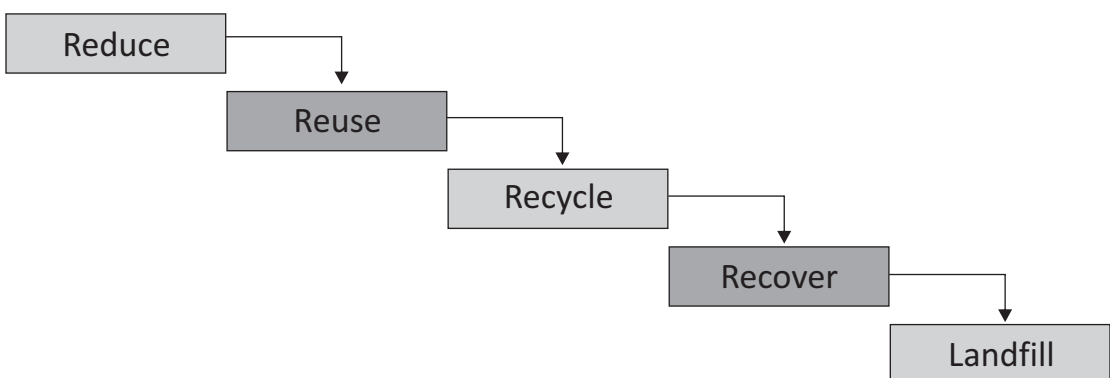


Figure 1. General waste management hierarchy

Sweden's view on sustainable waste management was supported by policy makers, public, industries, governments, universities and research institutes. By incorporating garbage collection fees, easy access to recycling stations, and awareness campaigns, the recycling rates in Sweden has increased significantly in the recent years. Some laws have also been formulated with respect to this regard, including a ban on landfilling combustible waste since 2002 and organic wastes since 2005. Even before

2004, about 96% of all glass packaging, 95% of metal, 86% of corrugated cardboard and 80% of electronic waste was recycled in Sweden. Wastes which could not be recycled, are recovered through biological and thermal treatment in form of biogas, bio fertilizer, electricity and district heat.

Borås Model

Back in 1996, more than 40% of wastes were landfilled in Sweden. But then with implementation of innovative and integrated new technologies for waste separation, fractionation, biological treatment, and thermal treatment, the landfilling reduced drastically to about 10% and then gradually approached zero landfill. Today in Borås, the household waste is sorted in 30 different fractions, which is either recycled or converted to electricity, fuel or heat. Almost zero percent is landfilled today, which is an enormous achievement. A key factor behind this success is the cooperation of the citizens. Children are taught at school about waste sorting and management. Furthermore, regular sports and social activities are conducted to create awareness among adults in the city. The success behind Borås waste management system has several crucial factors such as citizens, policy and decision makers, research and development and children. Policies are e.g. formulated in such a way that citizens pay less tax when the sorting rate goes higher and vice versa. At the University of Borås, a wide research program is performed to utilize the wastes into innovative value products.

Tons

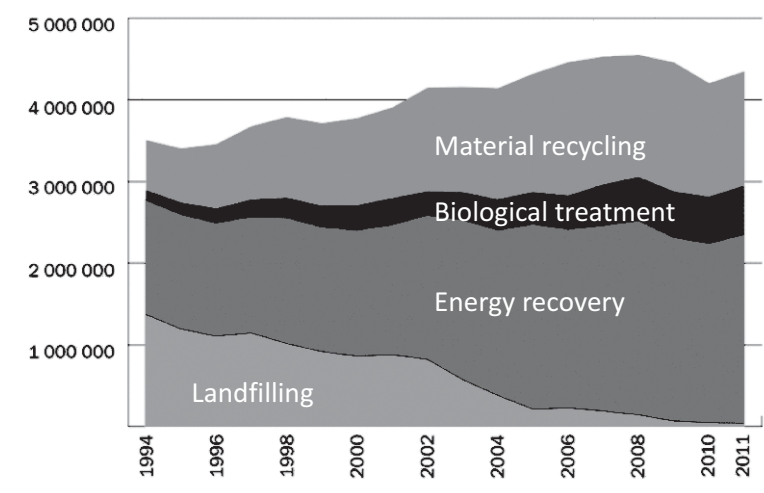


Figure 2. Household waste treatment in Sweden 1994-2011

In Borås, each household is given a booklet by the municipality which contains how to handle different wastes. Approximately, 130 different materials are listed in the booklet, so that the citizens could look what to be done with a particular waste. For example, white glass bottles are sorted separately and colored bottles are distinguished separately. The lamps are sorted in bulb, florescent, halogen, LED and other low energy lamps which are treated separately. Recycling containers are placed in walking

distances from each household all around the city to collect pure fractions of each material, which are sent to industries for further processing. The municipality also provides white and black bags for every household for free. All compostable waste is collected in black bags, while other waste goes in white bags for combustion. The black bags and other organic flows are sent to biological treatment for production of biogas. More than 3 million m³ biogas is produced every year, which is enough to run the buses in the city, garbage collecting trucks and around 300 CNG vehicles in the city. The white bags and other industrial waste are sent to two 20 MW combustion plants, where 960 MWh heat and electricity is produced every day. The complete block diagram of household waste flow is shown in Figure 3.

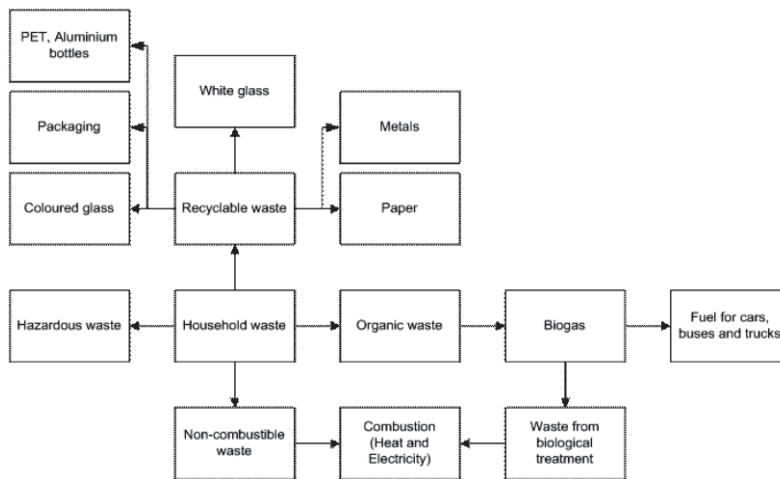


Figure 3. Block flow diagram of household waste flow in Borås

Another interesting way of recycling is the deposit system so called "Pant" in Sweden. According to this system, all PET, aluminum and some glass bottles are recycled in supermarkets by collection machines. Every time a PET or aluminum bottle is bought by the customers, an additional fee of 1-4 SEK is charged depending on the size of the bottle, which is returned when the empty bottle is returned to the collection machine. More than 90% recycling of PET and aluminum bottles has been reached in Sweden. This system is very attractive and innovative as managing the waste is easier, efficient and economic. Fraction of waste recycled, sent for biological and thermal treatment is shown in Figure 4.

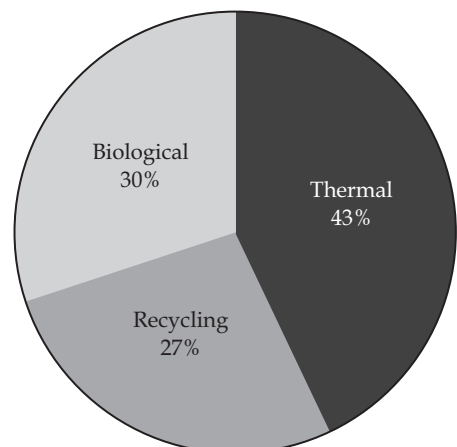


Figure 4. Fraction of waste utilized in different forms in Borås

Transferring the knowledge

Borås is now a zero waste city and it's time to think beyond Borås and Sweden. With this thought, sharing knowledge organization was founded namely Waste

Recovery – International Partnership (WR). In this organization the politicians, citizens, industries and the universities are brought under one roof and a Public, Private Partnership was created. The politicians discuss with the partner country to have better policies while industry implement the technology developed by the university. WR includes City council of Borås, Borås Energy and Environment AB, University of Borås, SP Technical Research Institute of Sweden and about 20 different companies involved in waste management. The international collaboration started in 2006 and now it is operational in Southeast Asia, Africa, Latin America, North America and Europe. WR is a non-commercial organization with an objective to see a better environment for the planet.

The collaboration could be at different levels for different countries, but the starting point of collaboration for any country has usually been started with collaboration between the two universities in Borås and the partner city. Universities play a major role as education is a powerful tool to initiate changes. University of Borås and its collaborating country university exchange faculty, researchers, and students at MSc and PhD level to develop an appropriate technology for the collaborating country. The industries and other members in the group will help in their part to achieve the goal. A research at PhD level called “Sandwich-PhD” where a student spends half time in the home country and half time at University of Borås specially working on the research aspects related to home country. The network also offers a specially designed course for companies and municipality employees in Sustainable Waste Management in Borås for 1-4 weeks which is usually followed up by one week in collaborative country. During this second part of the course, the local situation is analyzed to support strategic decisions for local development.

The first collaboration was made with one of the oldest Indonesian universities named Gadjah Mada University and Sleman municipality to create competence on waste management, research on biogas, good examples on waste sorting and converting fruit market waste into biogas for producing electricity. The fruit market produces 4-10 tons of fruit waste, which was dumped before. Now, the wastes are sent to biogas digester to produce 500 KWh electricity per day. Before the biogas digester was installed, around 14 truck of waste was landfilled every week and after the installation the number reduced to one.



Figure 5. Waste Recovery- International partnership collaborative model

University of Borås is invited to conduct workshops in various universities and municipalities all around the world, which is starting point for international networks and relationships for collaboration. Contacts created are shared with collaborating partners for possible collaborations. In parallel, the governments are connected through embassies for making a smooth and faster collaboration. When a collaborative initiative is taken, a mutual exchange of visits between Borås and the partner cities is to be started. The meetings are financed by the collaborating parties or international organizations or by different authorities in Sweden. After this initial step, decisions about the future collaborations are to be taken. WR in Borås expects the collaborative part to create a similar Public, Private Partnership. A good startpoint is to start student exchange and to organize the introduction course for mayors and other important people from the local society.

Conclusion

Borås is open to transfer knowledge and technology on waste management in a context of open innovation. Borås is open to share its knowledge developed during the last 30 years. With the Public, Private Partnerships created in Borås in collaboration with a Public, Private Partnership in another country, a strong productive international platform is created. The long term vision has to be a planet without waste but just resources.



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